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MP MASTER
MA22709

ADVANCE

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LOW DISTORTION OSCILLATOR SG 68

Range 1·5 Hz to 150 kHz

Instruction Manual

ADVANCE INSTRUMENTS

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The low distortion oscillator SG68 is one of a series of Advance signal generators. It provides both sine and square waves from 1.5 Hz to 150kHz, with very low distortion, hum and noise content, and good level and frequency stability over the whole range of the instrument. Typical sinusoidal Total Harmonic Distortion figures are 0.035% at 5Hz, 0.002% at 1 kHz and 0.1% at 150kHz.

Silicon semiconductors are used throughout the instrument. Either sine wave or square wave output is selected by means of a front panel 'Function' control, which also has an 'Off' position.

The SG68 is operated by internal batteries, but has provision for use with a battery eliminator fitted internally or externally, or with a suitable DC supply, details of which are given in the specification (Section 2).

FREQUENCY

1.5Hz to 150kHz continuously variable in 10 ranges as follows:-

1.5Hz to 4.5Hz
4.5Hz to 15Hz
15Hz to 45Hz
45Hz to 150Hz
150Hz to 450Hz
450Hz to 1.5kHz
1.5kHz to 4.5kHz
4.5kHz to 15kHz
15kHz to 45kHz
45kHz to 150kHz

Accuracy:- ±3% of reading ±0.2Hz at 20°C.

WAVEFORM

Sine or Square.
Square wave rise and fall times not greater than 100nSec.

SINEWAVE DISTORTION

At maximum output into 600Ω, 5 minutes after switch-on:-

Harmonic Distortion not greater than 0.01% from 20Hz to 20kHz.
Harmonic Distortion not greater than 0.05% from 20kHz to 50kHz.

OUTPUT LEVEL

0 to 4V r.m.s. sinewave or peak square wave open circuit continuously variable in 4 ranges by push button switch.

0 to 4mV
0 to 40mV
0 to 0.4V
0 to 4.0V

Level Control Accuracy:- ±0.25V r.m.s. open circuit) at 1kHz
Attenuator Accuracy:- ±0.5dB) and 20°C

OUTPUT LEVEL STABILITY

At constant temperature the output level remains constant within ±0.5dB of mean level over the entire frequency range of the instrument.

OUTPUT IMPEDANCE

Typically less than 10Ω on the 4V range at maximum level setting, increasing to approximately 250Ω at half maximum level. Typically 600Ω on other ranges irrespective of level setting.

FREQUENCY/TEMPERATURE VARIATION

Typically less than $\pm$0.05% per ^{o}C over the range 15^{o} to 30^{o}C.

POWER SUPPLY

3 Internal 9V Batteries, Vidor type VT9 or Ever-Ready type PP9 or equivalent. Minimum battery voltage 22V on load.

or Advance Battery Eliminator type BE2 operating from 100V-130V or 200V-260V. Single phase a. c. 45 to 60Hz. Consumption 6. 5W approximately.

or External supply 22V to 29V d. c.

Consumption - At 27V supply, 12mA on sinewave, 22mA on square-wave at maximum output into 600Ω.

External Supply Ripple: The instrument will tolerate supply frequency ripple on an external d. c. supply provided that the instantaneous voltage remains within the limits 22V to 29V

TEMPERATURE RANGE

Except as provided above, the instrument will operate within the range 0^{o} to 40^{o}C.

DIMENSIONS

11$\frac{1}{2}$" Wide x 7-1/8" High x 11" Deep (29. 2 cms x 19. 1 cms x 27. 9 cms).

WEIGHT

13. 5 lbs with batteries (6. 15 kgs)

3.1 GENERAL

Operation of the oscillator is straightforward. It may be operated either with internally fitted batteries or alternative supplies (See 3.3 and 3.4).

3.2 INTERNAL BATTERIES

To fit batteries, undo lid-securing screw and remove the lid. Connect the flying leads from the terminal board on the rear panel, also the battery connecting link, as shown in Fig. 1a. Note that two batteries are joined by means of the link, and that the green 'ground' lead is connected from the battery stowage link position to the ground stowage terminal.

3.3 EXTERNAL 22 to 29V DC SUPPLY

Batteries or battery eliminator should be disconnected, the link should be stowed on one terminal (bottom left) and the green 'ground' lead should be connected to the ground stowage terminal, as shown in Fig. 1b. The external supply (which should be capable of delivering at least 25mA) should be connected to the appropriate terminals on the panel, from the rear of the signal generator.

3.4 BATTERY ELIMINATOR TYPE B.E.2.

With the battery eliminator fitted internally in the battery compartment, connections and link should be as shown in Fig. 1c. With the battery eliminator used externally, the connections should be made as in 3.3, above.

WARNING The Function Switch OFF position switches off the instrument but does NOT disconnect mains from the battery eliminator.

3.5 AMPLITUDE STABILITY

For low frequency operation, a settling period of up to five minutes may be required from switch-on, or following a frequency change, before optimum amplitude stability is established.

3.6 OUTPUT WAVEFORM SELECTION

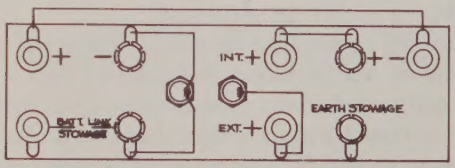
The Function Switch on the front panel serves to switch the signal generator off, or to set the output waveform to either sine or square wave. The selected waveform appears across the one set of output terminals.

3.7 FREQUENCY SELECTION

To select the desired frequency, set the FREQUENCY RANGE control to the appropriate range, then turn the FREQUENCY fine control. Locate the required frequency by observing the position of the pointer on the calibrated dial.

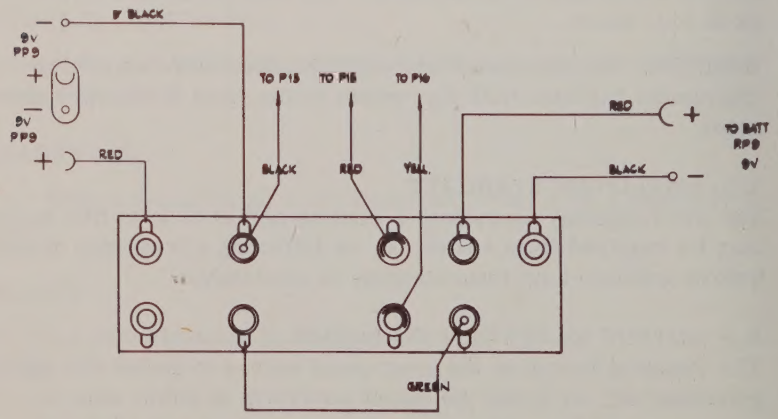
3.8 OUTPUT LEVEL SELECTION

With the attenuator set to the 'X1V' position, set the LEVEL control to the required position to give an output between 0 and 4V. At other settings of the attenuator, the corresponding outputs will be 0.4V, 40mV and 4mV maximum, for the settings 'X0.1V', 'X10mV' and 'X1mV' respectively.



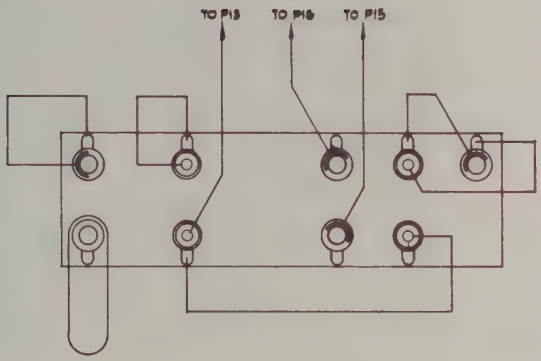
This wiring is permanently on the board whatever supply source may be used.

Fig. 1 Supply Board Connections



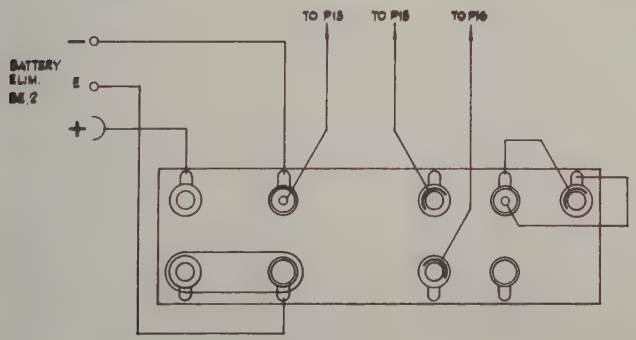
Note - this wiring to be used with wiring shown in Fig. 1

Fig. 1a Internal Batteries



Note - this wiring to be used with wiring shown in Fig. 1

Fig. 1b External DC Supply



Note - this wiring to be used with wiring shown in Fig. 1

Fig. 1c Battery Eliminator

4.1 GENERAL

The functional block diagram and circuit diagram of the SG68 are shown in Figs. 2 and 3 respectively. Basically, the signal generator comprises a Twin-T oscillator and a trigger circuit and squarer. The oscillator produces a sinewave output at frequencies between 1.5Hz to 150kHz. A ten-position switch, S1, and a fine control, RV2, enable the output frequency to be varied continuously over the whole range of the instrument.

Either sine or square waves are taken from the output terminals via the attenuator, switched by S3, and pre-set attenuator, RV9. The sine or square waves are selected by switch S2. The maximum calibrated amplitude of the output is 4V r.m.s. (sine wave) or 8V peak to peak (square wave).

4.2 TWIN-T OSCILLATOR

The oscillator comprises twin-TR.C. network C1-C33, R1-R3, RV1-RV2C and switch S1, and inverting amplifier and a thermistor network. With a properly balanced network, the twin-T passes all frequencies except the resonant frequency at which the rejection is infinite. In this circuit the network gives negative feedback at all frequencies other than the resonant frequency. However the twin-T network is unbalanced slightly so that the rejection at resonance is not infinite, and it is a property of an unbalanced network that, at resonance, the signal experiences a phase reversal so that the feedback becomes positive and oscillations occur. These would normally build up until limited by the circuit and would thus suffer severe distortion. A further negative feedback circuit formed by C34, R5 and RV5 together with a thermistor TH1 limits the loop gain of the amplifier at resonance to unity at 4V r.m.s. at the output.

4.3 SINE WAVE GENERATION

The following circuit description relates to the stable operational condition which is attained a short period after switching on.

The filter provides an output to the amplifier of approximately 12mV peak to peak at 1kHz; this is fed to VT2 base via a limiting resistor R6 and thence to a second emitter follower VT3. VT2 and VT3 stages in cascade provide an input impedance of approximately 1MΩ and a low impedance drive to the base of VT5. The mean output voltage of the amplifier is preset by means of RV6. VT5 operates as a 60dB voltage inverting amplifier stage, this gain being

largely achieved by means of bootstrapping R18 to the amplifier output via C42. At frequencies when the effective collector-base capacitance could cause instability due to phase shift, C43 and RV8 effect the necessary gain 'roll-off'. R19 provides emitter degeneration thus reducing phase shift and distortion. VT6 emitter load resistor, R21, is also bootstrapped to the output, thereby further reducing the loading of VT5. MR5 and 6 determine the quiescent current through the Class B operated complementary emitter follower transistors VT9 and 10. The amplifier output is set to approximately 4.2V r.m.s. by means of the termistor feedback potentiometer RV5.

At resonance, the unbalanced 'twin-T' filter provides 30db attenuation (at 1kHz), phase inverted with respect to the amplifier output voltage. At 1kHz the amplifier voltage gain is approximately 60db, but the excess loop gain of 30db is negated by means of negative feedback across RV5. The amplifier input voltage therefore comprises the sum of the negative feedback signal in series opposition with the fractionally larger filter output signal.

This oscillator configuration provides 100% d.c. negative feedback to stabilise the d.c. operating levels of the amplifier. Output level stability with change of frequency is maintained by virtue of the large ratio of amplifier input impedance to the filter variable output impedance.

The oscillator output impedance is nominally 1Ω at 1kHz, and will operate into an external minimum load resistance of 250Ω.

4.4. SQUARE WAVES

Sine waves are fed via R4 to a trigger circuit comprising VT1, VT4 and associated components. When VT1 is non-conducting, VT4 is conducting, and vice-versa. Switching times are extremely short compared with pulse duration, at all frequencies. RV4 is a preset mark/space ratio control since its value determines the DC base voltage at VT1. Square waves appear at VT4 collector with an amplitude determined by RV7, a preset which controls the maximum positive excursion of the square waves fed to complementary emitter followers VT7 and VT8. The output signal is fed to P8, via R33, the output current limiting resistor.

4.5 OUTPUT

Sine or square output may be selected by S2A and applied via C47 and the variable attenuator network RV9, R35 to R40, to the output terminals. With S2 set to "∽ ", the DC supply is disconnected from the squarer circuit to conserve battery life.

4.6 STABILISED SUPPLY AND CURRENT LIMITER

The supply voltage to the oscillator and squarer is fixed nominally at 20V by a stabiliser comprising VT11, R34 and MR7. When the current approaches 60mA, the potential drop across lamp 1LP1 reduces the output voltage. This provides protection for the instrument in the event of an excess HT current being drawn. The lamp is situated inside the instrument on the printed circuit board above the range switch spindle.

4.7 FUNCTION SWITCH, S2

The switch S2 has three sections, as follows:

(a) S2A - used to select either sine or square wave output.
(b) S2B - provides supply voltage to the trigger circuit on square wave position only.
(c) S2C - switches the input supply.

4.8 DC SUPPLY

The DC supply may be derived from one of three sources:

(a) three dry batteries Type PP9 or equivalent.
(b) one battery eliminator Type BE2, operated from a 100/130V r.m.s. or 200/260V r.m.s., 45/60Hz, AC mains supply.
(c) an external 22V to 29V DC supply.

Connections to suit the supply to be used are made by means of press-stud connectors on a supply board situated inside the instrument at the rear. When supply (a) or (b), above, is used, a check of the voltage may be made by connecting a suitable voltmeter to the sockets marked 'batt. test/ext 22 to 29V DC', and then depressing the red push button (BATT. TEST) on the front panel.

5.1 REMOVAL OF CASE

Remove the screw securing the lid at the rear, and lift off lid, remove four screws from the front panel and remove the two screws securing the instrument at the rear panel. Draw the instrument forward from the case complete with front panel and p. c. board. The connections to the supply board may be detached from the rear panel, but are sufficiently long to enable the instrument to be operated whilst out of the case. In the event of detaching the three leads from the supply board (black, green and red), reference should be made to Fig. 1, SECTION 3.

5.2 THERMISTOR REPLACEMENT

The thermistor is situated at the top of the printed circuit board, and its soldered connections are accessible between the board and frequency scale.

5.3 INITIAL SETTING UP

(1) Set RV8 to 4kΩ, set all other controls to mid-position and connect power supply.
(2) Set FUNCTION switch to sine, output to maximum and frequency to 1kHz.
(3) After one minute settling time, adjust RV6 so that the DC voltage between the +ve of C34 and ground is 10.5V ±3%.
(4) Adjust RV5 to give as nearly as possible a constant output voltage of between 4.1V to 4.3V r.m.s. unloaded output over the frequency range 450Hz to 1.5kHz.
(5) Repeat steps (3) and (4), above.

NOTE If HF oscillations occur on LF ranges, reduce RV8; if LF oscillations occur on HF ranges, increase RV8. Excess capacitive loading should be avoided.

5.4 ALIGNMENT INSTRUCTIONS

(1) Having carried out the initial setting up instructions, set frequency to 450Hz (450Hz to 1.5kHz scale) and align the pointer to the correct scale mark.
(2) Set anti-clockwise end-stop to operate when pointer is level with the left-hand edge of window.
(3) Set clockwise end-stop to operate when pointer is level with the right-hand edge of window.

(4) Set pointer to 1.5kHz and adjust RV1 and RV3 together to give an output of 1.5kHz.
(5) Set pointer to 450Hz and check the output frequency.
(6) If necessary, repeat steps (1), (4) and (5), setting pointer and RV1 and RV3 together to obtain the correct frequency alignment. Note output level at 1.5Hz.
(7) Switch to other ranges (except top range) and check frequency alignment at minimum and maximum scale frequencies, adjusting RV1 and RV3 together to achieve the necessary frequency alignment.
(8) Switch to 45kHz to 150kHz range and set pointer to 45kHz.
(9) Adjust C12 and C23 together to obtain the correct frequency of output.
(10) Set pointer to 150kHz and set C11 to give an output level equal to that obtained in (6), above.
(11) If necessary, adjust C12 and C23 together, to obtain correct output frequency.
(12) Repeat step (4) of initial setting up, 5.1, on frequency range 45kHz to 150kHz and repeat steps (8) to (11), above.

5.5 PHASE MARGIN ADJUSTMENT

(1) This adjustment sets the correct phase margin and gain fall-off at 50kHz. It is normally carried out when checking distortion at 50kHz, prior to distortion checks at lower frequencies.
(2) Measure distortion at 50kHz at maximum output into 600Ω, and set the distortion figure to 0.03% to 0.035% by further adjustment of RV8 if necessary

5.6 SQUARE WAVE ADJUSTMENT

(1) Switch to square wave, and set frequency to 1kHz at maximum output.
(2) Adjust RV4 for a 1:1 mark/space ratio.
(3) Set RV7 to give 4.1V peak.

5.7 DIAL, BEARINGS AND WAFER SWITCH

Add a drop of machine oil to the pulley and potentiometer bearings, and blow dust from the switch wafers at intervals of not more than one month, depending upon conditions.

5.8 BATTERY REPLACEMENT

See Paragraph 3.2. The normal life of the batteries under intermittent use should be approximately 400HRS at 4HRS/DAY on sine-wave at maximum output into 600Ω.

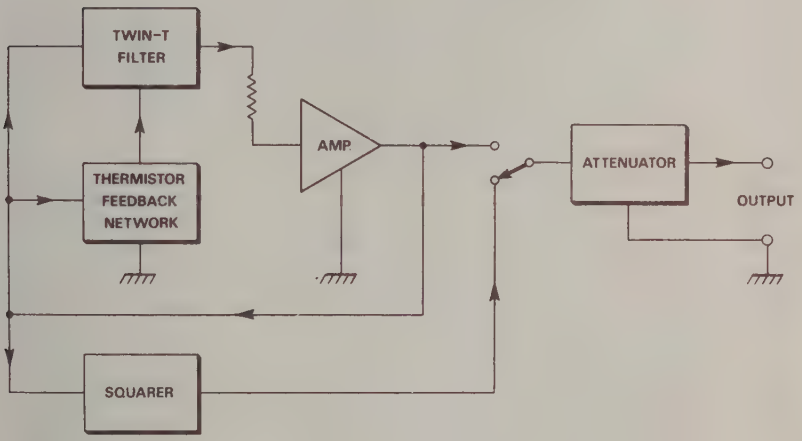


Fig. 2 Functional Diagram

Ref	Description	Part No
RESISTORS		
R1	20k Electrosil TR5 1%	23293
R2	9.1k Electrosil TR5 1%	23267
R3	20K Electrosil TR5 1%	23293
R4	470Ω 1/8W Cracked Carbon 5%	1373
R5	S.O.T. 1/8W Cracked Carbon 5%	
R6	100k Electrosil TR5 5%	19152
R7	10k 1/8W Cracked Carbon 5%	11503
R9	3.3k 1/8W Cracked Carbon 5%	1638
R10	68Ω 1/8W Cracked Carbon 5%	1640
R11	1k 1/8W Cracked Carbon 5%	384
R12	1k 1/8W Cracked Carbon 5%	384
R13	2.2k 1/8W Cracked Carbon 5%	425
R14	3.3k 1/8W Cracked Carbon 5%	1638
R15	3.9k 1/8W Cracked Carbon 5%	312
R16	1k 1/8W Cracked Carbon 5%	384
R17	1.5k 1/8W Cracked Carbon 5%	385
R18	4.7k 1/8W Cracked Carbon 5%	386
R19	22Ω 1/8W Cracked Carbon 5%	723
R20	1.5k 1/8W Cracked Carbon 5%	385
R21	2.7k 1/8W Cracked Carbon 5%	311
R22	2.7k 1/8W Cracked Carbon 5%	311
R23	1.5k 1/8W Cracked Carbon 5%	385
R24	10Ω 1/8W Cracked Carbon 5%	2259
R25	10Ω 1/8W Cracked Carbon 5%	2259
R26	22Ω 1/8W Cracked Carbon 5%	723
R27	220Ω 1/8W Cracked Carbon 5%	304
R28	22Ω 1/8W Cracked Carbon 5%	723
R29	22Ω 1/8W Cracked Carbon 5%	723
R30	10Ω 1/8W Cracked Carbon 5%	2259
R31	10Ω 1/8W Cracked Carbon 5%	2259
R32	22Ω 1/8W Cracked Carbon 5%	723
R33		
R34	3.3k 1/8W Cracked Carbon 5%	1638
R35	5.6k Electrosil TR5 2%	22483
R36	680Ω Electrosil TR5 2%	22484
R37	5.6k Electrosil TR5 2%	22483
R38	680Ω Electrosil TR5 2%	22484
R39	5.6k Electrosil TR5 2%	22483
R40	620Ω Electrosil TR5 2%	22485

Ref	Description	Part No
POTENTIOMETERS		
RV1	4.7k Plessey WMP	23266
RV2	60k ±2% + 60k ±2% + 30k ±2% inverse semi-log Colvern	23257
RV3	4.7k Plessey MPD	23266
RV4	10k Plessey MPD	2262
RV5	2.2k Plessey MPD	1756
RV6	22k Plessey MPD	1757
RV7	2.2k Plessey MPD	1756
RV8	15k Plessey MPD	18906
RV9	1k linear Colvern CLR 1106/28	22488
CAPACITORS		
C1	2.68µF±1%	1µF 125V W. Trop. M ±1% — 2364 1µF125V W. Trop. M ± 1% — 2364 0.68µF 125V W. Trop. M — 4540
C2	0.83µF±1%	0.68µF 125V W. Trop. M — 4540 0.15µF 125V W. Trop. M — 4538
C3	0.267µF±1%	0.22µF 125V W. Trop. M — 2601 0.047µF 160V Mullard C.296 AA/A — 792
C4	0.083µF±1%	0.068µF 160V Mullard C.296 AA/A — 796 0.015µF 160V Mullard C.296 AA/A — 782
C5	0.0267µF±1%	0.022µF 160V Mullard C.296 AA/A — 788 0.0047µF 400V Mullard C.296 AC/A — 776
C6	0.0083µF±1%	0.0068µF 400V Mullard C.296 AC/A — 780 0.0015µF 400V Mullard C.296 AC/A — 771
C7	2670pF ±1%	0.0022µF 400V Mullard C.296 AC/A — 773 470pF 5% Lemco. Insul. — 4781
C8	830pF±1%	680pF 5% Lemco. 3220 — 4784 150pF Lemco. 1510E. Insul. — 4514
C9	220pF ±1%	Lemco. 1510E. Insul. — 11587
C10	82pF±5%	Lemco. 1510 Insul. — 23274
C11	4-20pF	S. Triko. 004a/10B — 11580
C12	4-20pF	Triko. 004a/10B — 11580
C13	33pF	Lemco. 1106R Insul. — 23275
C14	100pF±1%	Lemco. 1510. Insul. — 12277
C15	330pF±1%	Lemco. 2515. Insul. — 4516
C16	0.001µF±10%	400V Mullard C.296 AC/A — 23273
C17	0.0033µF±10%	400V Mullard C.296 AC/A — 23272

Ref	Description	Part No
CAPACITORS Continued		
C18	0.01μF ±10% 160V Mullard C.296 AA/A	23271
C19	0.033μF ±10% 160V Mullard C.296 AA/A	23270
C20	0.1μF ±10% 125V Wima. Trop.M.	23269
C21	0.33μF ±10% Wima. Trop. M	23268
C22	0.1μF ±1% Wima. Trop. M	24186
C23	4-20pF Triko. 004d/10B	11580
C24	33pF ±5% Lemco. 1106R. Insul.	4779
C25	100pF ±1% Lemco. 1S10. Insul.	12277
C26	330pF ±1% Lemco. 2525. Insul.	4516
C27	0.001μF ±10% 400V Mullard C.296 AC/A	769
C28	0.003μF ±10% 400V Mullard C.296 AC/A	774
C29	0.01μF ±10% 160V Mullard C.296 AA/A	802
C30	0.033μF ±10% 160V Mullard C.296 AA/A	790
C31	0.1μF ±10% 125V Wima. Trop. M	2740
C32	0.33μF ±10% 125 Wima. Trop. M.	4539
C33	1μF ± 1% 125V Wima. Trop. M	2364
C34	400μF 25V C.437.AR/F 400	20784
C35	56pF ±10% G.P. Ceramic ERIE Disc No. 750 Style 801	22373
C36	0.68μF ± 10% Wima. Trop. M	4540
C37		
C38	27pF ±10% G.P. Ceramic ERIE Disc No. 330 Style 801	22369
C39	400μF 25V C.437 AR/F 400	20784
C40	400μF 25V C.437 AR/F 400	20784
C41	400μF 25V C.437 AR/F 400	20784
C42	400μF 25V C437 AR/F 400	20784
C43	100pF ±1% S/M Lemco.	12277
C44	0.1μF 30V	19647
C45		
C46	0.68μF ±10% 125V Wima. Trop.M	4540
C47	4000μF 25V Mullard C.431 BR/F4000 Size 9 Sleeved	4850
DIODES		
MR1		
MR2	ZF 9.1 Zener 9V	4667
MR3	OA 200 Mullard	1874

Ref	Description	Part No
DIODES Continued		
MR4	OA200 Mullard	1874
MR5	OA200 Mullard	1874
MR6	OA200 Mullard	1874
MR7	ZF 20 Zener 20V	19955
TRANSISTORS		
VT1	2N706 Texas D. 626	3146
VT2	2N3858 Gen. Elect. (minB of 20 at 10μA)	20237
VT3	2N3858 Gen. Elect.	20237
VT4	2N706 Texas D. 626	3146
VT5	2N3858 Gen. Elect.	20237
VT6	2N3905 Motorola	20818
VT7	2N3706 Texas D. 626	18252
VT8	2N3703 Texas D. 626	20819
VT9	2N3393 Gen. Elect.	19818
VT10	2N3702 Texas D. 626	19840
VT11	2N3706 Texas D. 626	18252
MISCELLANEOUS		
TH1	Thermistor, Selected Type	23292
1LP	Lamp, Indicator, 12V 1W Vitality No. 679 Wire-ended	24027
BT1, BT2, BT3	Battery Ever Ready PP9 9V (or equivalent)	22465

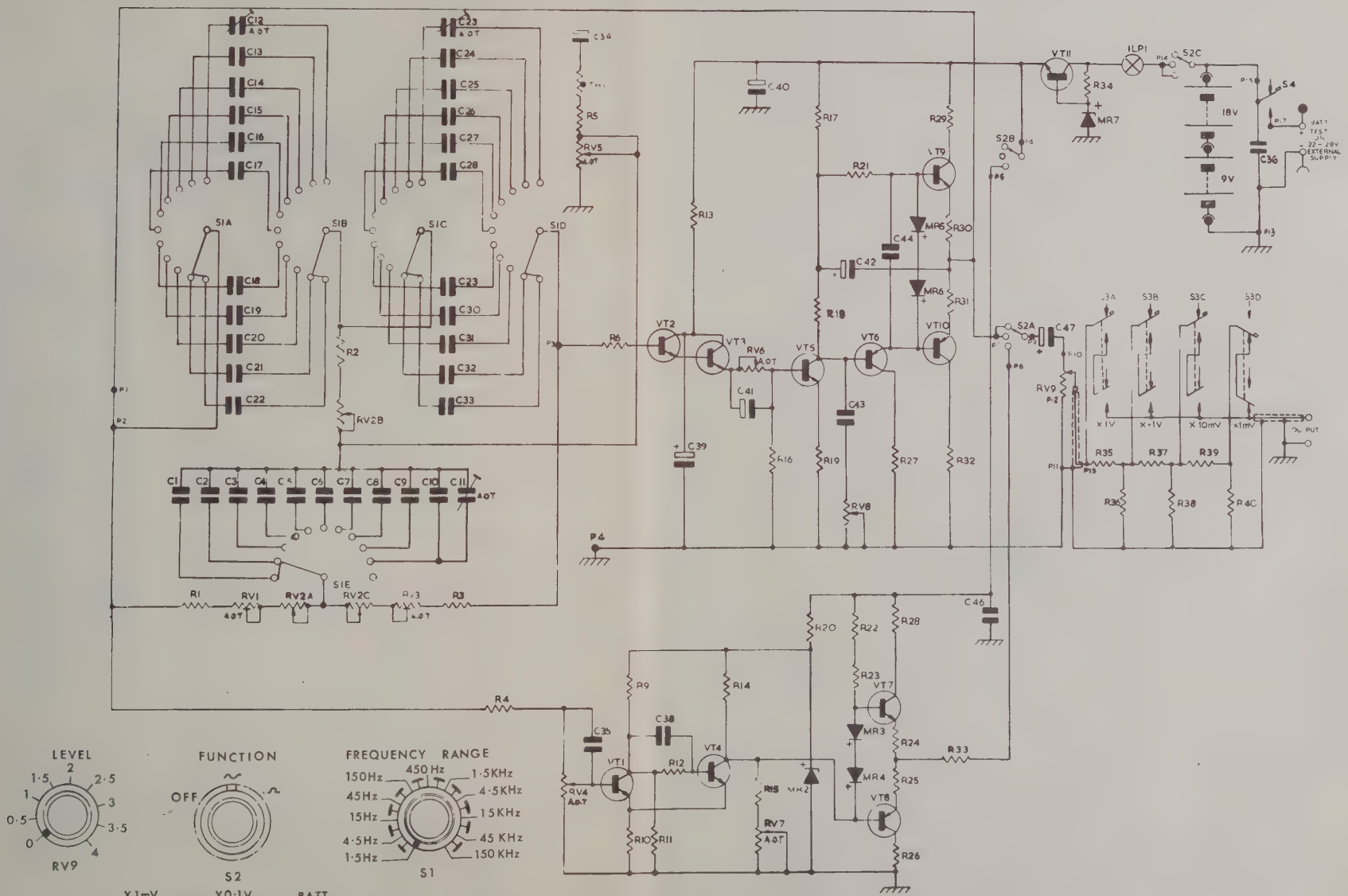


Fig. 3 Circuit Diagram

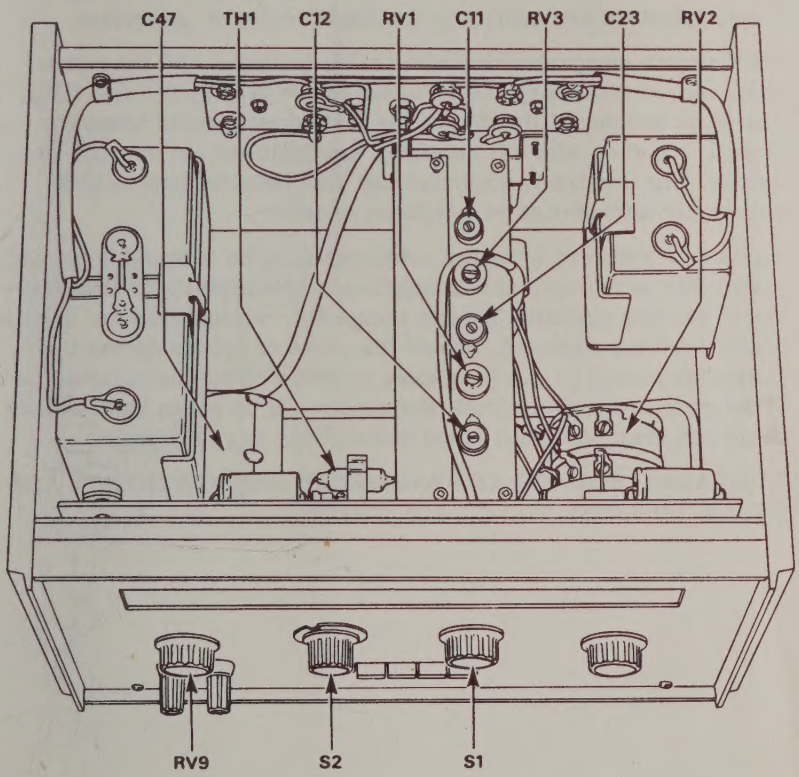


Fig. 4 Component Location Diagram

This instrument is guaranteed for a period of one year from its delivery to the purchaser, covering the replacement of defective parts other than tubes, semiconductors and fuses. Tubes and semiconductors are subject to the manufacturers ' guarantee.

We maintain comprehensive after sales facilities and the instrument can, if necessary, be returned to our factory for servicing. The Type and Serial Number of the instrument should always be quoted, together with full details of any fault and the service required. The Service Department can also provide maintenance and repair information by telephone or letter.

Equipment returned to us for servicing must be adequately packed, preferably in the special box supplied, and shipped with transportation charges prepaid. We can accept no responsibility for instruments arriving damaged. Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee has expired, the repair will be put in hand without delay and charged unless other instructions are received.

OUR SALES, SERVICE AND ENGINEERING DEPARTMENTS ARE READY TO ASSIST YOU AT ALL TIMES.

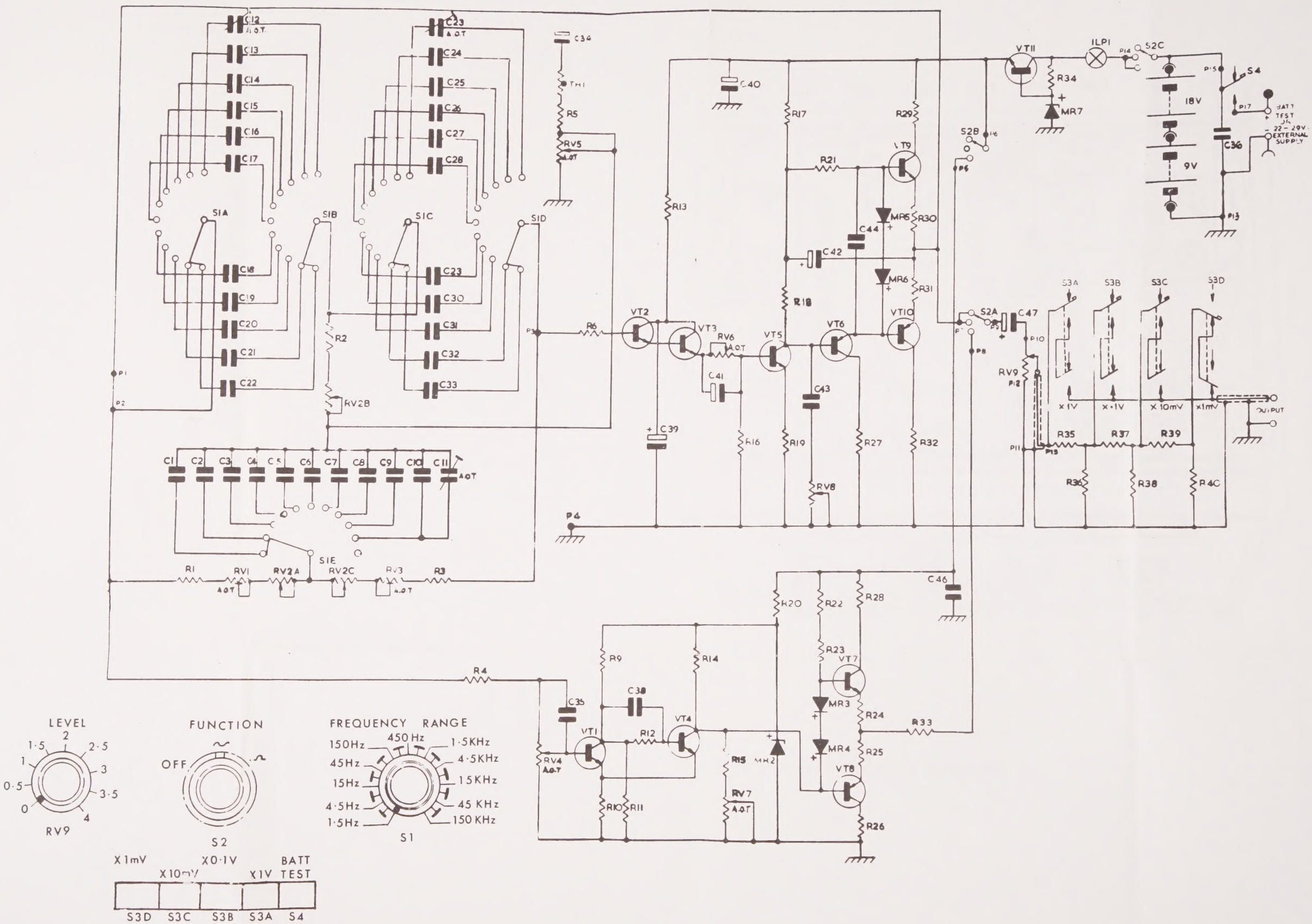


Fig. 3 Circuit Diagram

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